Global Lighthouse Network

Insights from the forefront of the 4th Industrial Revolution

January 2020
Executive summary

The latest findings from the Global Lighthouse Network, an ongoing research collaboration between McKinsey & Co. and the World Economic Forum, show that industrial leaders in applying Fourth Industrial Revolution (4IR) digital technologies are benefiting from a head start to generate even more value across the entire enterprise, and not just within factories.

This brief summary examines what the 44 Lighthouse manufacturers do differently; crucial insights for the vast majority of manufacturers that aren’t yet competitive with the leaders.

At least 70 percent of manufacturers are languishing in “pilot purgatory,” unable to bring manufacturing innovation to scale; they’re at higher and higher risk of falling permanently behind the leaders.

A detailed look at Lighthouse success cases reveals organizations that are driving outsized improvement in productivity, sustainability, operating cost, and speed to market.

A common thread across Lighthouses is that the digital journey begins with the transformation of the plant’s system of operations and is then propelled through 6 key scale-up enablers.

End-to-End (E2E) Lighthouses in particular are using technology to drive value for the enterprise in three ways: customer-centered design, seamless connectivity across functions, and continuous connectivity beyond organizations.

Transforming manufacturing from sourcing to delivery increases complexity and shifts stakeholder incentives as digital connectivity expands; addressing these changes requires breaking down internal divisions, sharing data externally, and building new capabilities, demonstrating the importance of the human element in successful technology application.

Adoption of 4IR technologies affect tasks performed and the ways in which people work together. Lighthouses are preparing their workforce through 6 common actions to maximize the potential of workers.
The Global Lighthouse Network includes 44 sites where 4IR technology is successfully deployed at scale

1. Zymogen
   Biotechnology, US
2. Fast Radius with UPS
   Additive manufacturing, US
3. Johnson & Johnson vision care
   Medical devices, US
4. Groupe Renault
   Automotive, BR
5. MODEC
   Oil and gas, BR
6. Johnson & Johnson DePuy Synthes
   Medical devices, IR
7. GSK
   Pharmaceuticals, UK
8. Schneider Electric
   Electrical components, FR
9. Groupe Renault
   Automotive, FR
10. Tata Steel
    Steel products, NL
11. Henkel
    Consumer goods, DE
12. Phoenix Contact
    Industrial automation, DE
13. AGCO
    Agricultural equipment, DE
14. Rold
    Electrical components, IT
15. Bayer
    Division pharmaceuticals, IT
16. BMW Group
    Automotive, DE
17. Procter & Gamble
    Consumer goods, CZ
18. Sanvik Coromant
    Industrial tools, SE
19. Nokia
    Electronics, FI
20. Arcelik A.S.
    Home appliances, RO
21. Petkim
    Chemicals, TR
22. Ford Otosan
    Automotive, TR
23. Saudi Aramco
    Gas treatment, SA
24. Unilever
    Consumer goods, UAE
25. Tata Steel
    Steel products, IN
26. Siemens
    Industrial automation products, CN
27. Infineon
    Semiconductors, SG
28. Danfoss
    Industrial equipment, CN
29. Weichai
    Industrial machinery, CN
30. Micron
    Semiconductors, SG
31. SAIC Maxus
    Automotive, CN
32. Petrosea
    Mining, ID
33. Foxconn Industrial Internet
    Electronics, CN
34. FOTON Cummins
    Automotive, CN
35. Danfoss
    Industrial equipment, CN
36. Weichai
    Industrial machinery, CN
37. Johnson & Johnson DePuy Synthes
    Medical devices, CN
38. Bosch
    Automotive, CN
39. Procter & Gamble
    Consumer goods, CN
40. Boa images iron & steel
    Steel products, CN
41. Haier
    Appliances, CN
42. POSCO
    Steel products, KOR
43. GE Healthcare
    Healthcare, JP
44. Hitachi
    Industrial equipment, JP
45. Petkim
    Chemicals, TR
46. Ford Otosan
    Automotive, TR
47. Siemens
    Industrial automation products, CN
48. Infineon
    Semiconductors, SG
49. Danfoss
    Industrial equipment, CN
50. Weichai
    Industrial machinery, CN
51. SAIC Maxus
    Automotive, CN
52. Haier
    Home appliances, CN
Lighthouses demonstrate what’s possible with measurable improvements in operations

<table>
<thead>
<tr>
<th>KPIs improvements</th>
<th>Impact range observed</th>
<th>Lighthouse example</th>
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</thead>
<tbody>
<tr>
<td><strong>Productivity</strong></td>
<td></td>
<td></td>
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<tr>
<td>Factory output increase</td>
<td>4-200%</td>
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<tr>
<td>Productivity increase</td>
<td>5-160%</td>
<td></td>
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<tr>
<td>OEE increase</td>
<td>3-90%</td>
<td></td>
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<tr>
<td>Product cost reduction</td>
<td>5-40%</td>
<td></td>
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<tr>
<td>Operating cost reduction</td>
<td>2-45%</td>
<td></td>
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<tr>
<td>Quality cost reduction</td>
<td>5-90%</td>
<td></td>
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<tr>
<td><strong>Sustainability</strong></td>
<td></td>
<td></td>
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<tr>
<td>Waste reduction</td>
<td>5-45%</td>
<td></td>
</tr>
<tr>
<td>Water consumption reduction</td>
<td>10-30%</td>
<td></td>
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<tr>
<td>Energy Efficiency</td>
<td>1-50%</td>
<td></td>
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<tr>
<td><strong>Agility</strong></td>
<td></td>
<td></td>
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<tr>
<td>Inventory reduction</td>
<td>10-90%</td>
<td></td>
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<tr>
<td>Lead time reduction</td>
<td>7-90%</td>
<td></td>
</tr>
<tr>
<td>Change-over shortening</td>
<td>30-70%</td>
<td></td>
</tr>
<tr>
<td><strong>Speed to market</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed to market reduction</td>
<td>30-90%</td>
<td></td>
</tr>
<tr>
<td>Design iteration time reduction</td>
<td>15-40%</td>
<td></td>
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<tr>
<td><strong>Customization</strong></td>
<td></td>
<td></td>
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<tr>
<td>Configuration accuracy increased</td>
<td>15-20%</td>
<td></td>
</tr>
<tr>
<td>Lot size reduction</td>
<td>55%-90%</td>
<td></td>
</tr>
</tbody>
</table>

Source: McKinsey & Company Lighthouse Analysis

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KPIs: Key Performance Indicators
OEE: Overall Equipment Effectiveness
Lighthouses are deploying 92 use cases with some focusing within the manufacturing site and others on connecting the E2E value chain (1/2)

## Manufacturing

### Digital assembly & machines
- Real-time locating system (RTLS) for key manufacturing components
- Cycle time optimization through big-data analytics on lines PLCs
- Light-guided assembly sequence
- Mixed reality to enable digital standard work/trainings
- Advanced IIoT applied to process optimization
- Artificial Intelligence-powered process control
- Digital lean tools (e.g., eKanban, eAndon, eSpaghetti)
- Artificial intelligence guided machine performance optimization
- Digitally enabled variable takt time
- Digitally enabled modular production configuration

### Digital maintenance
- Cost optimization of heavy operations through sensor analysis
- Machine alarm aggregation, prioritization and analytics enabled problem solving
- Predictive maintenance aggregating data based on historical and sensor data
- Real-time pipeline cost optimization based on edge sensors
- Remote assistance using augmented reality
- Analytics platform for deviation root-cause identification

### Digital performance management
- Analytics platform for remote production optimization
- Digital dashboards to monitor OEE performance
- Digital twin for remote production optimization
- Enterprise Manufacturing Intelligence system to upgrade operations management
- Integration platform to connect machine-level data with enterprise software
- Real-time asset performance monitoring and visualization
- Sensor-based manufacture KPI reporting
- Digital tools to enhance a connected workforce
- Digital recruitment platform tailored to shop floor
- Digital twin of sustainability
- Digitally enabled man-machine matching

### Digital quality management
- Scanning to replace and improve performance for high cost CMM (scans)
- Automated in-line optical inspection to replace end-product manual inspections
- Digital work instructions & quality functions
- Digitized standard procedures for line operations with integrated workflow
- Mixed reality glasses to guide operators in the end-of-line inspection
- Field quality failures aggregation, prioritization and advanced analytics enabled problem solving
- IoT enabled manufacturing quality management
- Digital quality audit
- Quality improvement by predictive analytics

### Digitally enabled sustainability
- Energy optimization by predictive analytics
- IIoT real-time energy data aggregation and reporting dashboard
- Sensor-based data collection for energy management
Lighthouses are deploying 92 use cases with some focusing within the manufacturing site and others on connecting the E2E value chain (2/2)

### End-to-end value chain

#### Supply network connectivity
- Aggregate demand across end-to-end supplier network
- Should-cost modeling to support make versus buy decisions
- Analytics driven procurement supported by spend intelligence & automated spend cube
- End-to-end real-time supply chain visibility platform
- Supplier and materials quality tracking
- Part traceability from unique digital tag based on surface scanning
- Digital supplier performance management
- Artificial Intelligence to accelerate scaling of digital applications across sites
- Joint data analytics with equipment OEM for process optimization

#### E2E product development
- 3D printing for rapid design prototyping
- 3D simulations / digital twin for product design and testing
- Testing automation
- Advanced analytics for performance management across the idea to market
- Product development using robotics
- Big-data / AI enabled product design and testing
- Virtual reality supported prototyping
- Digital thread implementation through product development lifecycles
- Rapid outsourced prototyping
- Crowd-sourcing & competitions to develop digital solutions

#### E2E planning
- Predictive demand forecasting
- Real-time S&OP
- Real-time inventory management (internal / external)
- Dynamic production scheduling with digital twin
- Dynamic network optimization
- Predictive inventory replenishment
- Analytics for dynamic warehouse resource planning and scheduling
- Dynamic simulation for warehousing design
- No-touch master planning (allocation to the plants)
- Digital integrated business planning
- Closed loop planning
- End-to-end real-time supply chain visibility platform
- Advanced analytics to optimize manufacturing and distribution footprint
- Production planning optimized by advanced analytics

#### E2E delivery
- Dynamic delivery optimization
- Robotics enabled logistics execution
- Digital track and trace
- Asset utilization and yard management for logistics
- No touch order management
- Digital enabled picking and transport
- Predictive maintenance in fleet assets
- 'Uberization' Of transport
- ATP based on real-time constraints
- Digital logistics control tower

#### Customer connectivity
- Connected devices to track and measure consumer behaviors
- Mass customization and B2C online ordering
- Delivering to customers wherever they are through new delivery solutions
- Customer end-user interface to configure and order a product, and track delivery
- Smart / intelligent packaging
- Customer analytics enabled by RFID
- Online communities for customer insights
- GPS based map and customer location
- 3D printing
- Connected devices to track and measure product performance
- Digital Twin of Customer System

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McKinsey & Company 6
The gap between the frontrunners and the majority continues to grow

Only a handful vanguards went from pilot to lighthouse and are starting to scale network-wide

Secret formula for scaling business impact decoded

~50
WEF lighthouses\(^1\) expected for 2020, first lighthouses with impact across the e2e network

71% of manufacturers stuck in pilot purgatory

1. Estimated based on pipeline of applications to the WEF

To escape pilot purgatory, Lighthouses become the scale-up vehicle for the entire company

Scale-up architecture
Lighthouses as scale-up vehicles

One
Company operating system
New way of working across value chains, people, assets and sites

Few
Lighthouses
Integrated 20+ use cases that together innovate a value chain or factory and allow to build the infrastructure to scale

50+
Use cases
Digital innovations that change how business/process is conducted

500+
Deployments
Local transformations that innovate the way we work across the organization

Scale-up Unit
Lighthouses create an MVP\(^1\) of the company wide IIoT operating system

Augmented-reality operators, robotics, and leaned-out, automated processes are simulated and optimized using digital twin methodology

Upskilled workforce with FoW\(^2\) ready profiles via an IIoT academy. Agile operating model fostered through agile digital studio

Modernized IIoT stack & data model allow cyber connection between reality (eg, shop-floor sensors) and IT systems, and agility to add use cases in matter of weeks (technology democratization)

Digital performance management—with AI-powered, personalized dashboards and alerts—creates one source of truth and eliminates waste in decision making

Scale-up enablers
Lighthouses build the infrastructure to scale

Agile approach
IioT stack
IioT academy

Agile digital studio
Tech ecosystem
Transformation office

1. Minimum viable product
2. Future of work
Key enablers are the secret sauce to scaling fast

### Scale-up enablers

Lighthouses build the infrastructure to scale

| **Agile approach** | Lighthouses iterate quickly, fail fast, and learn continuously. Create minimum viable products (MVPs) in two-week sprints, and bundle use-cases for fast transformations. This agile approach stands in stark contrast to year-long pilots that are designed for perfection. |
| **Agile digital studio** | To be agile, co-location of translators, data engineers, ERP systems engineers, IIoT architects, and Data Scientists is key, as is direction by product managers and an agile coach, who make sure that results are delivered in sprints and iterated fast. |
| **IIoT stack** | Lighthouses are preparing existing IT systems to design & modernize the next generation of technology capabilities, ensuring that selected IIoT architecture is sufficiently adaptable and future proof. |
| **Tech ecosystem** | Relationships supported by mutual exchange of large amounts of data and collaboration on technology platforms to facilitate the exchange and consumption. This is a notable shift from the age-old idea of safeguarding technology solutions and data as a competitive advantage. |
| **IIoT academy** | Given the need to reskill and upskill the workforce at scale, the development of effective learning methods focused on technology becomes critical. Examples include gamification, digital learning pathways, VR/AR learning, and AR and digital custom real-time work instructions. |
| **Transformation office** | Lighthouses that achieve scale have established governance models to support best practice exchange and prioritization with a focus on impact and solutions, as opposed to focusing principally on technology. |
Though Lighthouses have a common set of value drivers - E2E leaders deliver value in 3 distinct ways

<table>
<thead>
<tr>
<th>Value drivers across both areas</th>
<th>Value drivers in E2E Lighthouses</th>
<th>Lighthouses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology democratization and augmenting the operator</td>
<td>Customer centricity</td>
<td>Haier</td>
</tr>
<tr>
<td>Technology on the shop floor is transforming ways of working, as operators develop their own apps and solutions to facilitate and automate their tasks.</td>
<td>By placing customers at the center of process design and operations, organizations are improving the initial purchase experience as well as use over the product lifetime.</td>
<td>FAST RADIUS</td>
</tr>
<tr>
<td>Big data decision-making</td>
<td>Seamless connectivity across functions</td>
<td>Nokia</td>
</tr>
<tr>
<td>Decisions are not hypothesis-driven, but rather are based on big data deciphered by pattern recognition – and not by humans.</td>
<td>Seamless data exchange and transparency across functions reduces friction, allowing for more efficient decisions and reduction of redundant communications.</td>
<td>Zymeworks</td>
</tr>
<tr>
<td>Process and business model innovation</td>
<td>Continuous connectivity across organizations</td>
<td>Phoenix Contact</td>
</tr>
<tr>
<td>Fourth Industrial Revolution technologies enable the lighthouses to develop new business models that complement and/or disrupt the traditional business and value chain.</td>
<td>4IR technologies enable unprecedented data collection, exchange, and processing; this allows organizations to create new ecosystems in the manufacturing space.</td>
<td>Haier</td>
</tr>
</tbody>
</table>

Source: Fourth Industrial Revolution: Beacons of Technology and Innovation in Manufacturing
Lighthouses are taking common actions to prepare their workforce for change

<table>
<thead>
<tr>
<th>Lighthouses have invested in people</th>
<th>Transforming the ways in which people work together as part of the 4IR transformation is essential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keeping people at the center, empowering them to realize their full potential alongside that of digital technology, demonstrates that true 4IR innovation is directly entwined with people and that the Fourth Industrial Revolution is, after all, a human enterprise</td>
<td>Lighthouses are successfully navigating these changes through 6 common actions to maximize the potential of workers.</td>
</tr>
<tr>
<td>- Empowering the front line to innovate, using technology and data</td>
<td></td>
</tr>
<tr>
<td>- Proactively building capabilities, both technical and soft, and managing talent</td>
<td></td>
</tr>
<tr>
<td>- Adjusting the organizational structure to enable Fourth Industrial Revolution transformation</td>
<td></td>
</tr>
<tr>
<td>- Implementing new ways of working such as agile and increased transparency</td>
<td></td>
</tr>
<tr>
<td>- Improving day-to-day assembly and operating tasks through automation and technology</td>
<td></td>
</tr>
<tr>
<td>- Increasing levels of problem solving and collaboration on the front line</td>
<td></td>
</tr>
</tbody>
</table>
"From-To" illustrates these common actions impacting front-line workers' daily work and engagement (1/2)

<table>
<thead>
<tr>
<th>Empowering the front line to innovate, using technology and data</th>
<th>Example lighthouses</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Schneider Electric</td>
<td>Innovation in my production line is generated from the top</td>
<td>I own innovation in my production line—we all come up with ideas</td>
</tr>
<tr>
<td></td>
<td>Ford Otosan</td>
<td>I always see scorecards measuring the same KPI—but with different numbers</td>
<td>All our scorecards are based on data from a single source that now we all use to make decisions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I spend my time confirming data accuracy and inputting it into multiple report templates</td>
<td>My data is tracked automatically from hundreds of sources and feeds real-time into scorecards</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proactively building capabilities, both technical and soft, and managing talent</th>
<th>Example lighthouses</th>
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<th>To</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>P&amp;G Petrosea</td>
<td>I learn the basics to perform my job, but have limited opportunities to develop other skills</td>
<td>I have a customized reskilling program, adjusted for my abilities with digital technologies and accelerated multiskilling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>My company relies on our internal knowledge and experience to train our team, and it is limited to the first week on the job</td>
<td>My company uses innovative external methodologies for training, blending on-the-job coaching, rotations, augmented reality, and virtual stations or a digital learning center</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The talent-management system is one-size-fits-all, relying on expertise</td>
<td>Partnerships with universities and other companies offer new learning opportunities to learn from others, as part of an online platform with an individual training journey</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjusting the organizational structure to enable 4IR transformation</th>
<th>Example lighthouses</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bosch</td>
<td>I see many silos between IT functions and operations</td>
<td>We have new cross-functional team focusing on digital deployment</td>
</tr>
<tr>
<td></td>
<td>Nokia Arcelik</td>
<td>My team is production only—we only focus on running equipment</td>
<td>My team merges production and maintenance, with technicians and operators running automated operations</td>
</tr>
</tbody>
</table>
“From-To” illustrates these common actions impacting front-line workers’ daily work and engagement (2/2)

<table>
<thead>
<tr>
<th>Example lighthouses</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementing new ways of working such as agile and increased transparency</td>
<td>Solution development is finished outside of our operations before being tested</td>
<td>To develop a fit-for-purpose product, the agile team involves us early in minimum viable product (MVP) development, though sprint review</td>
</tr>
<tr>
<td>More than 90% of my shift tasks are repetitive and manual</td>
<td>My discussion with my supervisor is based on the last hour or day with limited data that does not help us problem solve—so its mostly just a review</td>
<td>My discussion with my supervisor uses real-time and relevant data for the losses we are having, so we can diagnose root causes and make decisions quickly</td>
</tr>
<tr>
<td>I rely on few support tools, mostly paper standard operating procedures (SOPs)</td>
<td>I have digital tools for real-time help (electronic SOPs, augmented reality)</td>
<td></td>
</tr>
<tr>
<td>I can only manage a few machines since they have frequent breakdowns, and I have to make adjustments based on my experience</td>
<td>My machines are self-learning with automated centerlining and other settings, which eliminates most breakdowns and allows me to track more machines in parallel</td>
<td></td>
</tr>
<tr>
<td>Increasing levels of problem solving and collaboration on the front line</td>
<td>I spend most of my time gathering data, yet most sessions lack all relevant data</td>
<td>I have relevant data available in a centralized source to use when needed</td>
</tr>
<tr>
<td></td>
<td>Decisions in my line typically are based on experience, not data</td>
<td>My team relies on self-diagnosing machine-based data to make decisions</td>
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</table>
### Appendix – Case studies

## Scale-Up enablers

<table>
<thead>
<tr>
<th>Enabler</th>
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<tbody>
<tr>
<td>Agile digital studio</td>
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<tr>
<td>Agile approach</td>
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<td>IIoT academy</td>
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<td>Transformation office</td>
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## Value Drivers

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</table>
Digital technology improves connectivity throughout the value chain allowing organizations to minimize the effects of deviations in production

**Schneider Electric** in Batam has created a platform for stakeholders to monitor and adjust to anomalies within its manufacturing processes

- **IIOT Platform**
  - Monitors and transfers real-time data to supplier informing any variations in production

- **Supplier Portal**
  - Communicates demand forecasts to suppliers facilitating more efficient inventory planning at the suppliers’ locations

- **QR Code**
  - Aids company and suppliers to effectively track and trace inventory throughout the value chain

**Key Impacts**

- +70% Supplier service rate
- -85% Administration time
- +40% On-time delivery

The right portfolio of interconnected technologies enables operational agility while minimizing efficiency costs

VR
Virtualization of R&D
Lessens time to market and helps identify quality issues early

Flexible Robotics
Rapid line changes to speed up NPI achieved through modularity
Multi-skill robotics to ensure flexibility in use

Automated Internal Logistics
Standardized point of use stock replenishment through automation
No touch material handling

Wireless network & cloud infrastructure
Robust private cellular network infrastructure allows for all machines to be upload and download data seamlessly
Enables plug and play of machines without rewiring LAN
Data from the cloud is inputted into analytics platforms to identify inefficiencies and correct those through planning

Ex. Impact on KPIs

Production lead-time
-80%

Standard unit per FTE
+90%

Process quality (PPM)
-50%

2016 17 18 2019
Digital planning overcomes inefficiencies by leveraging total data transparency across functions to make holistically efficient decisions.

*Key Impacts*
- 36% inventory reduction
- 90% time to market

**Analytics platform captures data throughout the process**

Analytics platform utilizes multiple machine learning algorithms to provide specific feedback to all segments of the value chain:

- Empowers root cause problem solving across all functions by utilizing the feedback to work on the deficient areas

The platform is enabled by an open communication protocol between all of the factory’s sensors in the line and the central cloud data storage.

Reduced amount of quality issues and rework based on improved design from data feedback loop.

**Digital Twin for Remote Production**

Production can be viewed across all sites

Allocates job to the site while solving for logistics and capacity of the sites
Organizations place customer experience at the core of their strategy and utilize technology to establish a link with performance management.

**Haier’s air conditioning unit** is achieving its transformational goal of moving from a one-time customer mindset to a **lifetime user mentality** by utilizing digital technology to connect customer experience with daily operations.

**Key Impacts**
- +21% quality improvement
- +63% in labor productivity
- -50% customer PM FTE
- -33% lead time

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**Product Purchase**
- Using interactive platform, customer customizes and places order

**Customer Complaint**
- Customer calls with any issues and the data engine retrieves the performance data from unit serial number

**Real-time Data Monitor**
- Customer PM analyzes unit performance data and any deterioration in performance is reported

**Team/Dept.**
- With the data provided from the system, the root cause of the customer’s issue can be addressed
  - If production worker error caused the fault, the appropriate individual’s record will be updated in the shop floor bonus system accordingly
    - If part error, parts will be examined to determine appropriate course of action

**Issue Solved**
- Using interactive platform, customer customizes and places order

**Lessons Applied**
- Customer PM analyzes unit performance data and any deterioration in performance is reported

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Haier Case Example for customer centricity
E2E Lighthouses continue to generate value outside the four walls by creating solutions that enable a differentiated customer centric experience

**SAIC Maxus** is utilizing digital solutions to revolutionize the **mass production of mass customized** vehicles to provide unprecedented service to the customers

**Key Impacts**
- -35% Time to market
- -20% Production lead time
- 99.8% Configuration accuracy
- -30% Tooling and changeover

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**Online Platform**
Customer uses web app to customize, order, and track status

**Digital Twin**
3D simulation to configure car as per customer order

**Digital Supply Chain**
Car configuration and production queue are transmitted to supplier to initiate Just-in-Sequence shipment

**Smart Engineering**
Automated system differentiates thousands of configurations to confirm correct build

**Quality Assurance**
AI tool continuously checks build progress to identify errors
As organizations foster cross function collaboration, they are able to achieve impact at scale rapidly

Key Impacts

+12% operational efficiency
-44% machine downtime
Digital connectivity enables an integrated and transparent operating model that results in value creation greater than the sum of each step in the value chain.

**Phoenix Contacts** uses RFID tags that carry information ensuring transparency and accessibility of data to all steps of the process.

- **Product Design**: Machine building department acts as R&D facility for rapid introduction of new solutions.
- **Testing**: Digital twin contains all testing specifications.
- **Production**: All the testing data is recorded and passed along to the production team.
- **Delivery**: Customer information and delivery details are known by production team and conveyed to the customer for real-time order status.

**Key Impacts**
- 24/7 running of the line
- +40% performance
- Up to -30% production time
- Unique products at cost of mass production
When utilizing a single repository of data, analytics and big data can effectively plan across functions and contribute to connectivity

Zymergen is employing advanced analytics and automation to digitize the traditional method of performing lab works

Sensor Network
Sensors at all processes collect data and verify that the process parameters are being met

Central Data Lake
All data stored in one location and effectively used across processes to improve connectivity

Digital Work Scheduling
System analyzes capacity, machine breakdown times, and inventory to schedule work centers and avoid costly errors

Digital Work Instructions
Cloud held data used to generate work instructions for operators and machines to greatly improve throughput rate

Modular Automation
In-house developed robots capable of using standard work tools are reliable operators and significantly cut costs

Key Impacts
+46% labor efficiency
-42% operating cost
-50% lead time
+40% line yield
The Global Lighthouse Network is a community of production sites and other facilities that are world leaders in the adoption and integration of the cutting-edge technologies of the Fourth Industrial Revolution (4IR).

Lighthouses apply 4IR technologies such as artificial intelligence, 3D-printing and big data analytics to maximize efficiency and competitiveness at scale, transform business models and drive economic growth, while augmenting the workforce, protecting the environment and contributing to a learning journey for all-sized manufacturers across all geographies and industries.

The Global Lighthouse Network is a World Economic Forum project in collaboration with McKinsey & Co, and the factories are chosen by an independent panel.

Want to learn more?


Read the full report at weforum.org/whitepapers/fourth-industrial-revolution-beacons-of-technology-and-innovation-in-manufacturing